to the theory in its existing state has pointed the way to its wide application in a great many cases. As the author repeatedly points out, the logical consequences of the electronic theory are still very far from being worked out in many of the subjects dealt with, and this task offers a fine field of investigation, which may ultimately lead to new results of the highest practical importance.

Probably nowhere is this more true than in the field of electrochemistry, of which, however, the treatment is somewhat superficial and unsatisfying. Another topic, which fares even worse, and yet is one of which much might have been, and ultimately will be, made, is the optical activity of carbon compounds. What little is said is so misleading, for example the last sentence of chapter xii., that it should be either omitted altogether or considerably amplified. In the main, however, the treatment is refreshingly clear and interesting.

Of course, it is to the explanation of that class of phenomena known as electromagnetic that the electron theory offers the greatest simplification. Consider a phenomenon such as "the spark on break due to the extra E.M.F. of self-induction," which is nothing but the electrical analogy of the water-hammer in a pipe when a cock is suddenly closed and the water stream stopped. For water read electrons, and for pipe read conductor, and even a beginner gets a clear mental picture of the phenomena. That all magnetic and electric phenomena are to be explained by definite motions and properties of the individual electron is a simplification that may be expected to ameliorate the lot of the future student considerably. The electron theory provides for electricity that clear mental image of the processes involved, without which physical theories stagnate and become metaphysical. Nevertheless, the faculty of being able to think in more than one system is not easily acquired, and it is doubtful, for example in magnetism, if anyone trained on the present systems will ever really abandon them.

In addition to the topics already alluded to, chapters are devoted to the electronic treatment of thermo-electricity, the Hall and allied effects, optical phenomena, the Zeeman effect, radiation, voltaic electricity, radio-activity, and the electric discharge. One chapter is devoted to a speculative effort, bold and imaginative, but logical, well considered, and unexceptionable, on the similarity of the infinitely great phenomena of the cosmos with the infinitely small of the electronic universe. Finally, a new system of electrical quantities is advocated, in which electricity, represented by E, ranks as a fundamental quantity with length, mass, and time. The author uses throughout the expressions "company of electrons," "army of electrons," to represent respectively the E.S. unit (2930 million) and the coulomb (8·79 trillions), and thus once for all reduces electric quantities to a definite *number* of electrons.

Different readers will no doubt derive most benefit from different chapters according to their individual knowledge of the subjects referred to, but the book may be recommended to all interested in the progress of physical science. Dr. G. Johnstone Stoney, whose portrait appears as a frontispiece, contributes a preface to the work.

F. S.

OUR BOOK SHELF.

Manual of the New Zealand Flora. By T. F. Cheeseman. Pp. xxxvi+1199. Published under the authority of the New Zealand Government. (Wellington: J. Mackay, 1906.)

THE number of botanists who have contributed towards a knowledge of the New Zealand flora during the last forty years is remarkable, especially when it is recognised that their labours followed on discoveries made by earlier explorers and collectors of eminent repute. Banks and Solander, Colenso, Sinclair, and Hooker are a few of the early botanists whose work was collated in the "Handbook of the New Zealand Flora," compiled by Sir Joseph Hooker and published in 1864. Since that date, besides Colenso, Thomas Kirk stands out prominently as an energetic collector and author; he collected not only throughout both the main islands, but also visited several of the adjacent groups. Owing to his extensive acquaintance with the subject, in 1894 he was commissioned by the Government to prepare a flora of New Zealand, but the work was only half completed at the time of his death three years later. The task was subsequently entrusted in 1901 to Mr. Cheeseman, who has contributed numerous papers on new species, on the floras of Three Kings and Kermadec Islands, and on special methods of fertilisation in various genera. The wisdom of the choice is seen in the exhaustive and careful compilation now published.

The arrangement follows the plan of Hooker's earlier work, and to students of British botany acquainted with Bentham's "British Flora" this manual presents a familiar disposition.

Turning to the subject-matter, as the result of the last forty years' work, the computation of ferns and flowering plants has risen from about one thousand to nearly sixteen hundred species—exclusive of those naturalised—spread over 382 genera. With regard to orders the predominance of Compositæ is natural, but the flora is unusually rich in ferns and species of Scrophulariaceæ, and poor in species of Leguminosæ. The number of species in some of the genera is very large, amounting to forty-three in Celmisia, of which all are endemic with one exception; Veronica shows eighty-four species, of which, in contrast to our conception of the genus, seventy-one form shrubs or small trees. The flora contains many curious plants and unique associations that have been graphically described by Dr. L. Cockayne, but from a systematic point of view the most extraordinary fact is found in the enormous proportion of endemic species, amounting to nearly three-quarters of the total.

In working through a flora of such vast dimensions and containing so many exclusive species it will be comprehended that Mr. Cheeseman has accomplished a task of no small magnitude, and from the critical notes accompanying the technical diagnoses an idea is obtained of the wide knowledge and judicious discrimination that he has brought to bear upon it. The author and the New Zealand Government are both to be congratulated on the successful completion of the work.

Evidence of incorporation of the latest discoveries is found in the new genus Townsonia and various new species. The author has provided in the appendices a

synopsis of orders arranged according to Engler's syllabus, a summary of naturalised plants, and a list of native names.

Side-Lights on Astronomy and Kindred Fields of Popular Science: Essays and Addresses. By Prof. Simon Newcomb. Pp. vii+350. (London and New York: Harper and Brothers, 1906.) Price 7*s.* 6*d.* net.

In bringing up to date and publishing in book form this collection of essays, which have from time to time appeared in various American journals, Prof. Newcomb has provided us with a volume which is at once interesting and instructive. The range of subjects is a wide one, extending from a discussion of the question, "Can We Make It Rain?" to the flying machine and the structure and extent of the universe.

The chapter on the making and using of a telescope should prove interesting to anyone who uses this instrument, whilst "The Fairyland of Geometry" will provide food for thought for many hours to those amateur astronomers whose acquaintance with the science has been restricted to observation only.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Radium and Geology.

In considering the influence of radium on earth history, it appears to be generally assumed that the radium detected everywhere in the surface materials of the earth is an original constituent of the igneous rocks. An entirely different view has been lately pressing itself upon me. I put the view forward mainly because I think there are difficulties in the way of accepting the original or primary nature of the radium in rocks. These objections I first briefly state.

The original nature of the radium cannot be maintained without at the same time assuming the presence of the associated uranium to make good the radio-active decay. Now it is easy to show that if such uranium existed grave difficulties arise from the facts of solvent denudation. The ocean which receives the dissolved rock materials must be in an entirely different state from what is observed. Even assuming geological time as only a very few million years, the quantity of radium now in the ocean should be much greater than has been observed. If the river supply of dissolved rock materials had been sustained for only some 20×10^6 years, the sea-salt should possess a richness twenty-five times as great as the ascertained amount.

In stating this I make the assumptions—which I think, however, are not easily evaded—that radio-active substances are removed from the land along with other mineral matter, and that, along with radium brought into river water on the break-up of rock minerals, the postulated uranium is also carried to the ocean. On these assumptions we can arrive at an approximate estimate of what should be the existing state of the ocean on any possible estimate of geological time.

We do not require accurate figures. We are only really concerned with their order of magnitude. I take, in the first place, the Hon. R. J. Strutt's estimate of the radium in sea-salt, stated to be approximate only. The quantity is $0 \cdot 15 \times 10^{-12}$ grams per gram. From this there must be in the ocean about 8×10^9 grams. I assume the oceanic mass as $1 \cdot 468 \times 10^{24}$ grams. On Dr. Boltwood's result for the value of $\lambda(\text{year})^{-1}$ for radium, to maintain this quantity there must in some way be brought into the ocean $1 \cdot 78 \times 10^6$ grams of radium per annum.

I now turn to the approximate river supply. We have Sir John Murray's estimate of the total volume of river water and the dissolved matter therein, which annually enter the ocean. The dissolved matter amounts to $5 \cdot 1 \times 10^{15}$ grams. If we suppose the matter in solution still to possess the mean radium content of the igneous rocks as determined by the Hon. R. J. Strutt, that is, 5×10^{-12} grams per c.c. (and the application of this number can be justified on data at our disposal), we find that 10^4 grams of radium enter the ocean annually from the waste of the land. It will be seen, in the first place, that this quantity, unless the uranium enters along with it, is not nearly what is required to maintain the oceanic radium at its approximate present value; but if, on the other hand, the associated uranium enters along with the radium, in 8×10^5 years there would be such an accumulation of uranium in the ocean as to account for the existing amount of radium. But we have not to deal with 800,000 years. If geological time was but a few million years, and solvent denudation had progressed as here assumed, the facts as regards oceanic radium would be entirely different from the observed facts, even allowing a wide margin of error in all the data involved. In 100×10^6 years there should be $0 \cdot 19 \times 10^{-10}$ grams of radium per gram of sea-salt. I neglect the rate of decay of uranium, as this rate involves periods of the order of thousands of millions of years.

Is there any way of evading this difficulty? If we assume the uranium to be in some way caught in the sediments, and so brought again into dry land, we must expect to find a concentration to occur in them; but the facts are the other way. The average radium content of the sediments appears to be less than half (2×10^{-12}) that of the parent igneous rocks, and is, in the case of the detrital sediments and on the assumption of the original nature of the radium, presumably what remains behind with the less soluble constituents of the parent rocks. Nor can we suppose the uranium retained in the soils, for then we must face a still more extraordinary concentration of radium, whereas the soils are apparently poor in radium. If it is supposed to be concentrated in the rocks beneath the soils, difficulties have to be faced with other heavy metals. And in this case, of course, examination of the surface rocks tells us little as to the radium-content of the deeper lying rocks, save that these should contain much less. We are observing, in fact, the concentration products of about a mile and a half deep of parent rock removed by the wear and tear of geological time, and know not the depth to which these products extend. But such a continued accumulation on the land is hard to comprehend. It appears to me that the simplest conclusion is that there is no associated uranium generally distributed throughout the surface materials of the earth. I of course do not refer to the ore bodies, thermal springs, &c. Again, in certain igneous masses uranium undoubtedly exists occluded in the minerals, whatever history we may ascribe to it.

But if there is no associated uranium, whence comes the radium everywhere distributed over the surface of the earth? It cannot be from volcanic sources. These are entirely too local in their influence. Nor yet can we suppose it to reach the surface, as ores in general do, by means of fissure veins, &c. These, again, are quite local in their influence. Indeed, the Hon. R. J. Strutt points to examples of this in the case of the uranium deposits; the adjacent igneous rocks were not abnormal in their radium content.

By a process of exclusion, if for no other reason, we are, I think, justified in considering the possibility that the radium is picked up by the earth in its motion through space. The probable source would be the sun. There are, in point of fact, many arguments in support of this view besides that by exclusion. The fairly uniform distribution over the earth's surface at once finds explanation. The picked-up radium probably floats in the atmosphere for a long time, and ultimately is helped downwards to the surface by rain and snow, and other meteorological conditions. Once upon the surface of the land, percolating waters will carry it to all depths to which such waters penetrate. It has many thousands of years for its travels